



## Risø annual report 2003

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RISØ ANNUAL REPORT 2003

EFFECT





## MISSION

Risø's mission is to promote value-generating and sustainable technological development within the areas of energy, industrial technology and bioproduction through research, education, innovation and consultancy.

## VISION

Risø's research **shall push the limits** for the understanding of nature's processes and interactions right down to the molecular nano-scale level.

The results achieved **shall set new trends** for the development of sustainable technologies within the areas of energy, the manufacturing industry and biotechnology.

The efforts made **shall benefit** Danish society and lead to the development of new large billion-kroner industries.

## COLOPHON

Risø's activities in 2003 are reported in the following publications: Risø Annual Report (available in Danish and English), Risø Annual Performance Report (Danish) as well as the annual reports of the research departments (English). All of these publications and more information are available at [www.risoe.dk](http://www.risoe.dk).

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# *Taking up the challenge*

RISØ'S FOUNDATION IS – AND ALWAYS HAS BEEN – INTERNATIONAL RESEARCH OF THE HIGHEST STANDARD. THEREFORE WE COULD ONLY NOD APPROVINGLY WHEN THE DANISH PRIME MINISTER SPOKE IN HIS NEW YEAR SPEECH ABOUT HIS AMBITION TO MAKE DENMARK ONE OF THE LEADING HIGH-TECH SOCIETIES IN THE WORLD. WE ARE READY TO TAKE UP THE CHALLENGE AND CONSEQUENTLY, IN THIS ANNUAL REPORT, DIRECT FOCUS ON THE EFFECT OF OUR RESEARCH.



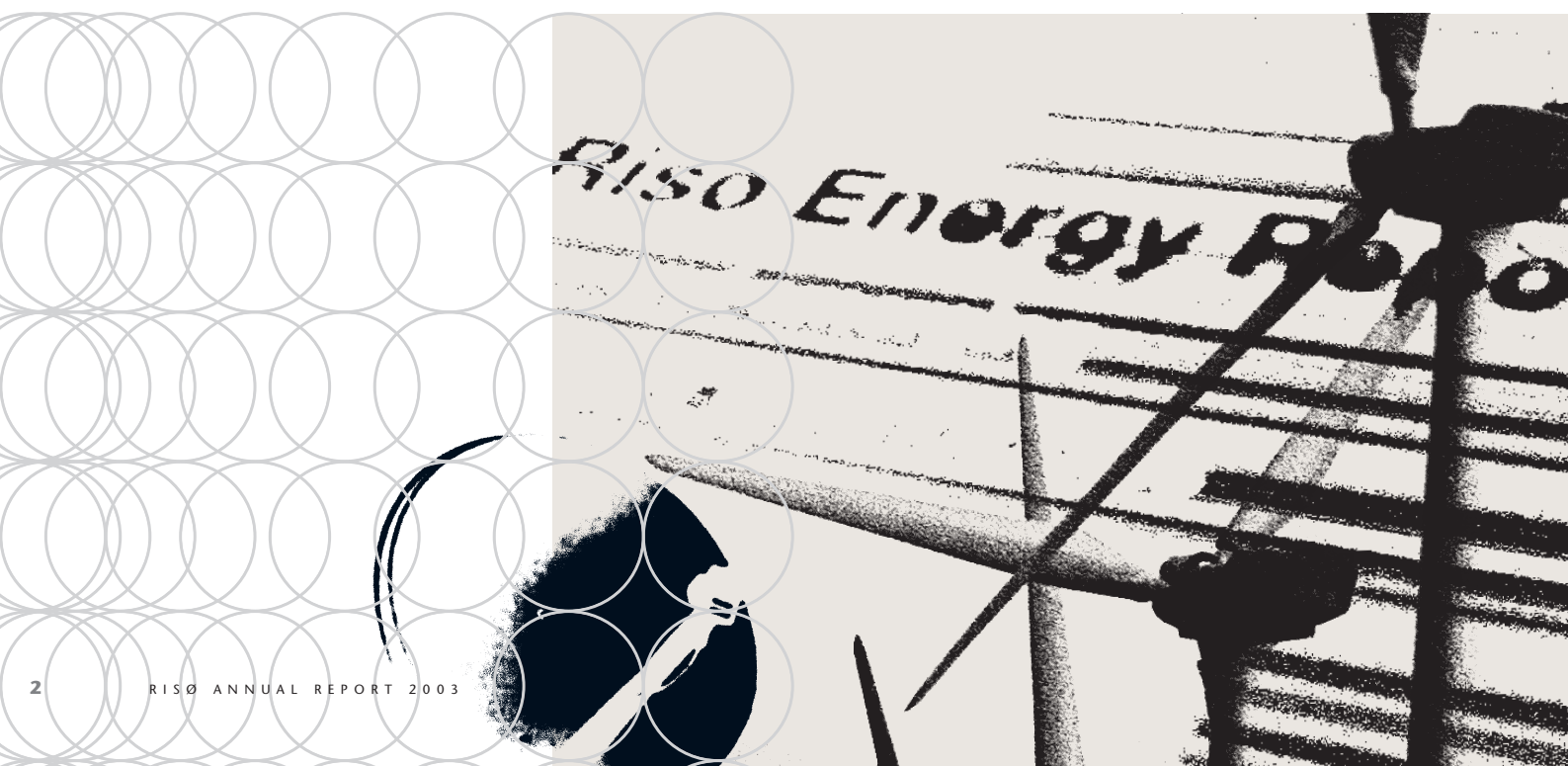
A handwritten signature in dark ink, appearing to read 'J Clausen'.

Jørgen M. Clausen  
Chairman of the Board of Directors



A handwritten signature in dark ink, appearing to read 'J Kjems'.

Jørgen Kjems  
Managing Director



2003 has confirmed that research at Risø is right at the forefront of developments within areas such as wind energy and fuel cells. It has been uplifting to see how well Risø's reports and research results have been received and the effect they have had on our surroundings: the political system, our partners within trade and industry and the education system as well as colleagues and scientists worldwide. We have helped to set the agenda, and we are contributing to making Denmark one of the world's leading high-tech societies.

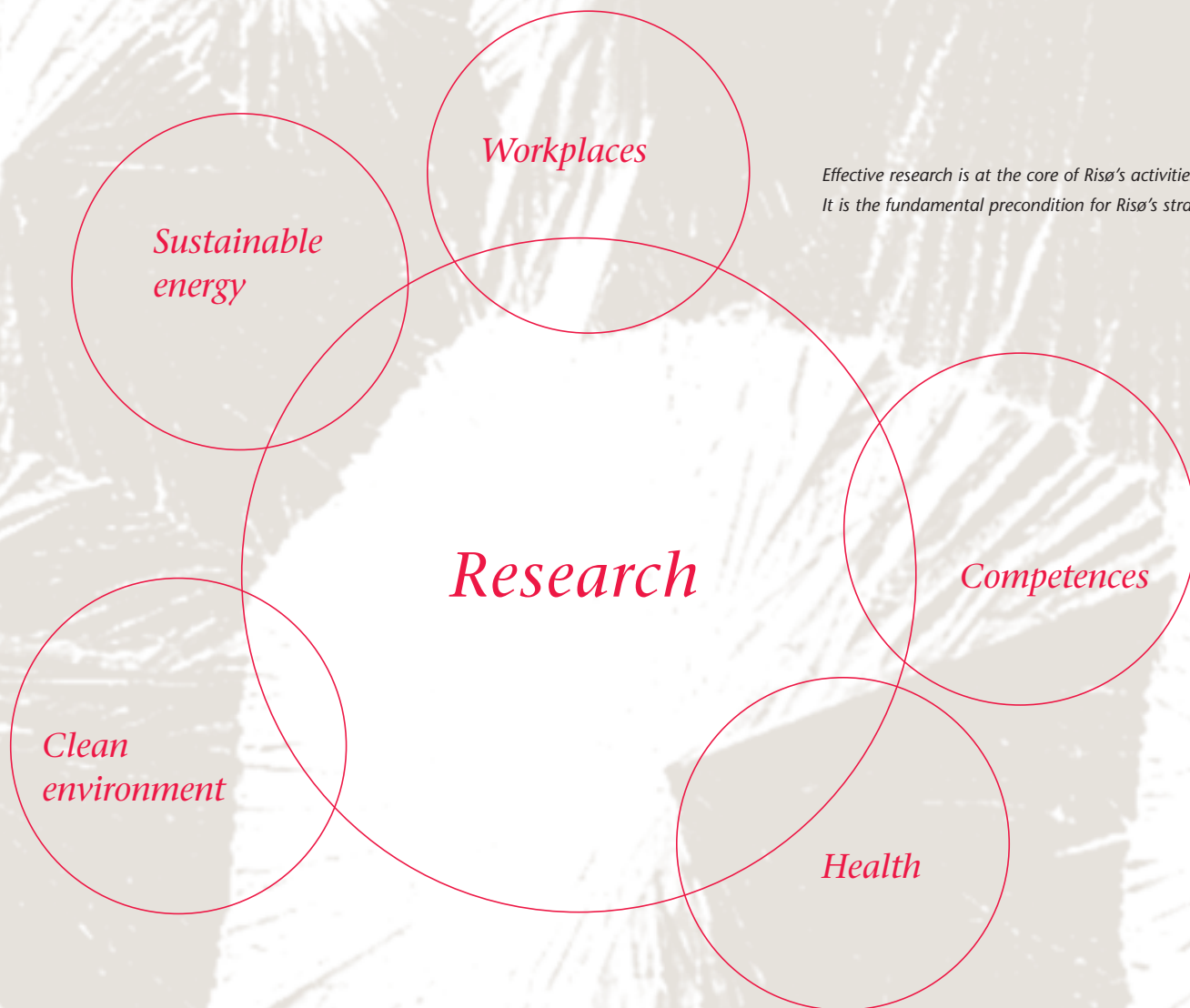
#### **Knowledge, values and welfare**

The reason for the government's statement is the national challenge facing us all: How do we safeguard workplaces, prosperity and welfare in the midst of intensifying globalisation? One of the answers is research-based innovation and education. And, of course, in a form where a synthesis is formed between research, innovation and education. This is the challenge we have taken up in 2003.

We have developed our collaboration with the universities within the field of education with a range of new or renewed agreements, and we have worked systematically with innovation, involving experienced businessmen as well as scientists and investors. At the same time, our energy reports have identified specific possibilities for developing the technologies which will guarantee the energy supply in the future.







#### **Effect in several fields**

In 2003, we have started the trial production of fuel cells, and results look promising. Uniform, durable SOFC fuel cells have been produced in large quantities, probably marking the start of proper commercial production.

Within the field of wind energy, a test centre for large wind turbines at Høvsøre has become fully operational in 2003, and thus a fruitful platform for product development as well as close collaboration between Risø and the wind turbine industry have been fully established. We are continually gaining new experience, which helps to maintain and strengthen the competitiveness of scientists and businesses alike.

In 2003, Risø's involvement in the Musicon Valley development environment was covered by the international science journal "Nature" when we participated at the annual Roskilde Festival, Europe's largest music festival. This is a good example of new paths to innovation.



### **Integrated educational profile**

In 2003 we entered into new agreements or renewed existing agreements with the University of Copenhagen, the University of Southern Denmark, Aalborg University and Roskilde University. Our collaboration with the Danish Institute of Agricultural Sciences (DIAS) and the Royal Veterinary and Agricultural University (KVL) has intensified through the formation of a consortium within plant biotechnology. We have high hopes of this collaboration.


By integrating research and education, we are not just creating better conditions for future recruitment – we are also gaining new and specific insights, such as when, for example, we involve students from the business school in evaluating the market potential of a given project. Here the students can spot pitfalls and new opportunities which we may have overlooked.

### **The sustainable future**

Environmentally sustainable energy forms have always enjoyed a central position in Risø's research and continue to do so. It is thus the long-term perspective in which we are interested, even though we are also working on projects with shorter time-frames. We like to regard ourselves as pioneers, helping to create new workplaces and new industries on a sound foundation.

In 2003, the nuclear facilities were demerged as an independent organisation, Danish Decommissioning, with a view to decommissioning the facility.

Finally, many thanks to all Risø employees for their impressive efforts in 2003, work which has benefited both Risø and all our partners in business, politics and the educational sector. In 2004 we will continue to pursue our course of making Denmark one of the world's leading high-tech societies.



What does the dictionary say?

"Effect" comes from the Latin *effectus* = performance. It is comparable with concepts such as: force, result, powerful effect, sensation, work, power. There is also a physical definition of effect, the energy consumed per unit of time – measured in watts (W). However, here we use the word effect in the first sense of the word.

## *Bohr still leaving his mark*

NIELS BOHR, DENMARK'S GREATEST PHYSICIST, WAS ONE OF THE DRIVING FORCES BEHIND THE ESTABLISHMENT OF RISØ. THIS MARKED THE START OF A PROCESS THAT TURNED RESEARCH, RESEARCH POLITICS AND RESEARCH-BASED KNOWLEDGE INTO IMPORTANT TOPICS IN SOCIETY.

The original idea behind Risø was to ensure that Denmark didn't fall behind in the rapid development of nuclear energy. Thus, Risø was not an aim in itself but a means to ensuring Denmark's technological advances within the energy field so that Denmark could help lead the way.

Risø became the means because scientific research was seen as providing the key to development, growth and welfare. Risø was to rearm research in Denmark, for which reason numerous debates about research and its role in society have had Risø on the agenda.

Today, Risø is a national research laboratory working across a large number of scientific fields. However, even though many new technologies have since emerged, the foundation remains the same as when Niels Bohr was alive: Risø exists for the sake of society. Risø must continue to secure a technological lead for Denmark.

# Effect – theme of the year 2003

WE HAVE CHOSEN "EFFECT" AS THE THEME FOR THE RISØ ANNUAL REPORT TO EMPHASISE HOW OUR RESEARCH FUNCTIONS IN CLOSE INTERPLAY WITH OTHER PLAYERS IN SOCIETY, AND THE EFFECT OF THIS RESEARCH ON SOCIETY AT LARGE.

There is nothing new in the fact that Risø has an effect on our surroundings. This has been the case since Risø was inaugurated in the summer of 1958 under the title "Serving the interests of society", and now it is possible to see the effects of our research in areas such as energy, clean environment, health and employment. These are areas where we play a key role and share in the responsibility for Denmark's continued development with growth and welfare top priorities.

## Wind energy still growing

The object of meteorological research was originally to calculate the spread of radioactivity. We still make this expertise available to society, but it has also served as a springboard for leading international research into wind energy and for a global industry. The answers were, literally speaking, blowing in the wind. New questions just needed to be asked. Find the answers on pages 8 and 9.

## New, budding energy industry

It was through wanting to solve Denmark's energy problems that nuclear research was initiated. However, this research also proved to bear the seeds of a technology like the ceramic fuel cells. They are soon to be launched onto the market and over the long term may have a positive effect on sustainable energy research, the environment and employment. See pages 10 and 11.

## Bridge-builder in global energy research

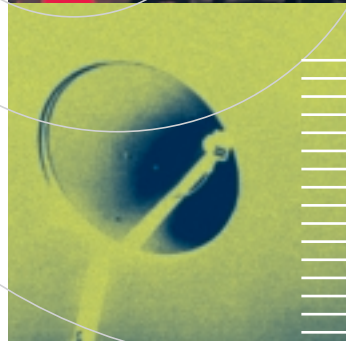
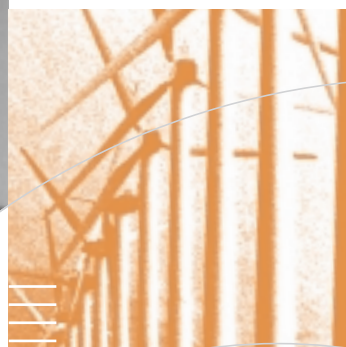
On the basis of wide-ranging energy research, Risø has become an obvious bridge-builder, working with the global community's energy supply at an overall level. One of the results is a new series of energy reports that provide the necessary overview and help to set the political agenda in Denmark as regards our future energy supply. Read more on pages 12 and 13.

## On stage in the entertainment industry

As an offshoot of its original energy research, Risø is participating in the Euratom programme for fusion energy. This has provided Risø with a high level of expertise in mapping the conditions in the red-hot interior of a fusion reactor using, for example, microwaves. This expertise is applied in many other contexts, and will now have a potential effect within the experience industry, as can be seen on pages 14 and 15.

## Growing interaction with the health sector

Ever since Risø was established, the laboratory has conducted research into the radiation doses to which people are subjected, and advanced dosimeters have been developed for registering radiation doses. This leading expertise is now being utilised within the health sector, and has for example paved the way for more precise radiation therapy for cancer patients. Read more on pages 16 and 17.



# EFFECT



A sustainable energy supply for future generations. This is the long-term effect of Risø's wind energy research. With our comprehensive know-how, wind energy centre, test stations and test facilities, we are able to supply knowledge and results which are put into practice by the wind turbine industry.



*"Within the fields of materials research and calculation methods, we have seen a considerable spin-off effect of our work with wind energy, also in relation to other areas of research. There is no question about this".*

*Peter Hjulær Jensen, Programme Manager*

*"Risø plays a key role in the continued development of wind energy. Only through targeted research can Denmark maintain its position as a global leader".*

*Bjarne Lundager Jensen, Director  
Wind turbine industry*

## DEVELOPMENT LINE

*In 1978, a handful of experts carry out research into wind energy; the turbines are small and of a static design. The first results are analysed.*


*Using aeroelastic calculations and more advanced test methods, the wind turbines become ever bigger and more powerful.*

*The WASP calculation model for wind resources becomes an international standard for the industry.*



# From niche to global export success

FEW OF RISØ'S RESEARCH AND KNOWLEDGE-SHARING ACTIVITIES HAVE HAD SUCH A SIGNIFICANT AND DIRECT EFFECT AS OUR RESEARCH INTO WIND ENERGY. TOGETHER WITH WIND TURBINE MANUFACTURERS, BLADE MANUFACTURERS AND UTILITY COMPANIES A BILLION KRONER INDUSTRY HAS BEEN CREATED.




At [www.wasp.dk](http://www.wasp.dk), you can read more about the wind resource calculation model which has become an industry standard. Denmark's Wind Turbine Association is the overall organisation for those interested in wind energy, and it can be found at [www.danmarks-vindmoelleforening.dk](http://www.danmarks-vindmoelleforening.dk). Finally, the Wind Energy Centre's own page – [www.risoe.dk/vea/](http://www.risoe.dk/vea/) – contains numerous links to organisations and research projects.

In 2003, the test centre at Høvsøre in Western Jutland was completed. This is where Risø and the wind turbine manufacturers are working on the testing and development of even larger wind turbines. In 25 years, the hub height has grown from 18 to 112 metres, and turbine output now exceeds 4 MW. At Risø's blade test centre at Sparkær near Viborg, manufacturers are able to test the blades for the next generations of wind turbines.

In 2003, a quantum leap has taken place with the "numerical wind tunnel" where, using a computer, it is possible to calculate precisely the loads to which

a wind turbine is subjected. Optimising wind turbine design is just one of the results.

In both areas – practical testing and theoretical calculation – Risø's results have contributed to pushing technological developments forward in a close interplay with the political system as well as commercial players within the wind energy sector. The effect of this is clearly reflected in the figures: The wind turbine industry now generates revenues of DKK 25 billion a year, while wind turbines cover more than 20 per cent of Denmark's electricity supplies.



*The blade test centre at Sparkær and the test station for large wind turbines at Høvsøre are supplying much sought-after knowledge.*

*Probability calculation of design, WASP Engineering for calculating wind load in complex terrain.*

*Future perspective: Sustainable wind energy with turbines optimally integrated into the national grid accounts for Denmark's second-largest export product.*

RISØ HAS STARTED A COST-EFFECTIVE TRIAL PRODUCTION OF FUEL CELLS IN ORDER TO GAIN FURTHER EXPERIENCE ABOUT THE TECHNOLOGY AND THE MANUFACTURING PROCESS. THE OBJECTIVE IS TO PAVE THE WAY FOR LARGE-SCALE INDUSTRIAL PRODUCTION.



## Energy production for the future

In 2003, Risø has, together with Haldor Topsøe A/S, manufactured several thousand fuel cells of a uniform quality. The mass production of fuel cells has thus taken a major step forward. In moving from laboratory scale to industrial scale, the use of fuel cells in the energy supply of the future has now become a realistic possibility.

The fuel cell consists of a membrane (electrolyte) which permits oxygen ions to pass through – but not electrons. Oxygen ions from the air side pass to the fuel cell side of the cell. The fuel may, for example, be natural gas, pure hydrogen, methanol or biogas. Water and carbon dioxide are formed and electrons released. Chemical energy is thereby transformed into electricity and heat as well as water and carbon dioxide.

The challenge involves two things: Optimising the fuel cell and the materials which are being used. And optimising the production process to lay the foundations for the simple and cheap mass production of uniform, high-quality fuel cells with as high a power density as possible. Work has taken place on both fronts over the previous year.

Fuel cell research at Risø really got under way in 1990, and the future looks exciting. Søren Linderøth, Programme Manager, has no doubts: "Fuel cells will have a bearing on the future energy supply in Denmark. It will provide us with a sustainable method of producing electricity and heating".

*"We are now much closer to being able to mass produce fuel cells, and this offers an exciting perspective for the Danish energy supply industry".*

Søren Linderøth, Programme Manager



*"Banco is investing in sustainable companies, which, among other things, is about reducing environmental impacts. Fuel cell technology looks extremely promising as it can reduce the future environmental impact of companies".*

Kirsten Fjord, CEO  
Banco Investment Association



### DEVELOPMENT LINE

In 1985, fuel cell research gets under way at Risø National Laboratory.

Better and better fuel-cells are developed.

A close partnership is set up between Risø, the electricity utilities, the Danish Energy Authority, DTU and Haldor Topsøe A/S.

Fuel cells enable efficient, clean and silent energy production which converts natural gas, for example, into heat and electricity. It can reduce our contributions to the greenhouse effect, while eliminating nitrogen oxide pollution.



The fuel cells project has its own home page – [www.sofc.dk](http://www.sofc.dk) – where visitors have access to the information which has been compiled.

Please note that the home page contains many films and animations which describe both the operating principle, research results and the underlying technology.

Risø is working closely together with Haldor Topsøe A/S – [www.topsoe.dk](http://www.topsoe.dk) – which will be responsible for commercialisation of the technology.

## EFFECT



A test plant at Risø for manufacturing fuel cells represents an important step towards commercialisation.

Mass production of fuel cells is growing, and many Danish households now receive their energy from fuel cells.

Future perspective: Fuel cells account for much of the energy supply to private homes, industry, cars and equipment.



Risø



Important decisions need to be made on a sound and future-oriented basis, not least by the government and parliament. Risø's energy reports have helped to strengthen the politicians' decision-making platform as regards the planning of the energy supply of the future.

*"With the energy reports, we are drawing on Risø's internal knowledge, our international networks and our know-how within system analysis".*

Hans Larsen, Head of Department



*"Risø is undergoing an exciting period of development. The widening of the scope of Risø's activities to include more energy technologies means that we benefit greatly from their analyses and research".*

Mogens Arndt, Director, Energi E2



At [www.risoe.dk/aktuelt/energisite](http://www.risoe.dk/aktuelt/energisite), visitors have access to a wealth of information about modern bio-energy. Here, it is also possible to download Risø Energy Report 2 which focuses on bioenergy.

It is possible to read more about the UNEP Risø Centre for Energy, Climate and Sustainable Development at the following home page:  
<http://uneprisoe.org/>

# Energy Report

## Reports with an impact

RISØ IS RESPONSIBLE FOR MUCH OF THE DANISH ENERGY RESEARCH. THUS, IT WAS NATURAL TO SYSTEMATISE THIS KNOWLEDGE AND LOOK AT ENERGY IN AN INTERNATIONAL CONTEXT. THE RESULT IS ENERGY REPORTS WITH CONSIDERABLE IMPACT.

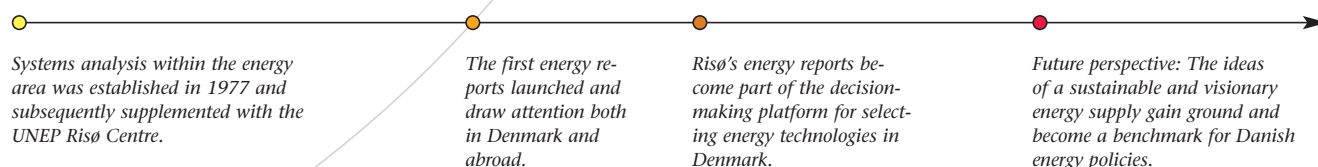
Risø Energy Report 2 was published in 2003 and looks at bioenergy. The report concludes that a fivefold increase in the world's total bioenergy production is a realistic objective. The report also concludes that Denmark has the best preconditions for taking the lead as far as the international development of technologies for modern bioenergy is concerned.

Risø Energy Report 1 took an overall look at the energy technologies of the future and assessed their potential and time-frame. This was then weighed up against Denmark's aim of complying with the Kyoto protocol, just as the possibilities for Danish research, product development and commercialisation were also assessed.

The reports were studied closely in Denmark and the EU and have paved the way for conferences and exchanges of experience. In the long term they will contribute to the establishment of a better decision-making platform within the energy area. The third report is being written and will focus on hydrogen as an energy carrier. The energy reports are prepared in close cooperation between Systems Analysis and Risø's technical-research departments, supplemented with important contributions from Danish and international experts in the field. This ensures the quality and creditability of the reports.

Systems analysis within the energy area has developed over the past two decades, and in 1990 it was supplemented with the UNEP Risø Centre, the work of which includes renewable energy in developing countries.

### DEVELOPMENT LINE



# Through the sound barrier

RISØ BROKE THE SOUND BARRIER WITH ROSKILDE FESTIVAL, MUSICON VALLEY AND WIRELESS AUDIO TRANSMISSION FOR BIG CONCERTS. RISØ'S INVOLVEMENT MAY HAVE A KNOCK-ON EFFECT IN THE EXPERIENCE INDUSTRY.

**Production-ready project:** With 50-100 GHz microwaves, it is possible to transmit sound from the stage to loudspeaker towers without cables. The microwaves cannot be intercepted, they are easy to manage and they are also sufficiently powerful so as not to be distorted by rain, dust or birds. Risø scientists have developed a prototype to demonstrate that the technology works in practice.

It was the first attempts at using microwaves to transmit sound – combined with our presence at the annual Roskilde Festival – which enabled Risø to break the sound barrier to the national and foreign media in 2003. Rock and Risø was a good appetiser for how scientific and technical-scientific research can find new applications in unexpected fields.

“It is my philosophy that we, as scientists, thrive best in a problem storm where we are constantly being faced with new challenges,” says head of department Jens-Peter Lynov. “For us as experts in lasers, microwaves and plasma, it was an obvious opportunity to work with the wireless transmission of sound and images in connection with Musicon Valley”.

Musicon Valley is a growth environment born of the Roskilde region and the Roskilde Festival. On the basis of the region's cultural resources, educational institutions and private companies, the objective is to create a growth centre in the Øresund region, at the heart of future development and where experiences are on the agenda.

Over the next ten years, it will be the culture and experience economy that will keep the wheels spinning for Denmark. The figures support this: Last year, the experience sector in Denmark exported one and a half times as much as the entire agricultural sector.

## DEVELOPMENT LINE

The Musicon Valley fund established in 2001 with the aim of fostering development within the experience industry.

Musicon Valley named as a regional growth environment, and receives official support from the Danish Ministry of Science.

Risø participates in Musicon Valley and develops the first ideas for projects. Participates at Roskilde Festival.

The first project – the microwave transmission of sound – demonstrated at Risø for politicians and decision-makers.

Further projects are initiated, and the first projects made ready for commercialisation.





## EFFECT



At [www.musiconvalley.dk](http://www.musiconvalley.dk), there is more information on how the initiative will develop to become an international powerhouse for the experience industry.

"Denmark in a culture and experience economy" from the Danish Ministry of Culture elaborates on the societal perspectives ([www.kum.dk/6537.asp](http://www.kum.dk/6537.asp)).

The Optics and Plasma Research Department can be found at [www.risoe.dk/opl/](http://www.risoe.dk/opl/)



"Musicon Valley is based on knowledge and relations. Risø can contribute in both these respects, while at the same time benefitting considerably from being confronted by unexpected challenges".

*Jens-Peter Lynov, Head of Department*



"For me, Musicon Valley presents an ideal opportunity to build on some excellent initiatives to create new companies in the experience industry of the future".

*Kim Ove Olsen, Director of the CAT science park and Chairman of the Board of Directors of Musicon Valley.*

*Future perspective: Musicon Valley makes a significant contribution to the experience industry, a clear export success.*

# Improved control of radiation doses in cancer treatment

WITH A VERY SMALL OPTICAL FIBRE DOSIMETER PLACED CLOSE TO THE TUMOUR, IT IS POSSIBLE TO PRECISELY MEASURE HOW MUCH RADIATION THE CANCER PATIENT RECEIVES DURING TREATMENT.

**More precise results and a more targeted treatment of cancer patients and consequently less inconvenience. The effect of the medical dosimeters being developed at Risø will enhance the quality of life for patients with a difficult diagnosis. Research at Rigshospitalet and University Hospital Malmö confirms that the system holds out considerable potential.**



*"I hope that the the system will go into production so that all hospitals and doctors can optimise their radiation therapy of cancer patients".*

*Lars Bøtter-Jensen, Project Manager*



*"The results have been satisfactory, and we believe that the dosimeter offers considerable potential for use with radiation therapy and diagnostics".*

*Sören Mattsson, Professor, University Hospital Malmö*

Over the past year, Risø has developed medical dosimeters based on optically stimulated luminescence (OSL). In brief: Via a thin optical fibre cable, it is possible to stimulate a small aluminium oxide dosimeter with a laser beam. The dosimeter releases the stored energy in the form of light which indicates the size of the radiation dose.

In radiation therapy, it is decisive that cancer patients receive the correct dose, and that the beam is precisely targeted at the tumour. Too small a dose has insufficient effect. And too large or too imprecise a dose is dangerous for the body's sensitive organs. A tiny dosimeter can immediately provide accurate feed-back.

"By doing things on a very small scale, we can direct the dosimeter very close to the tumour," says project manager Lars Bøtter-Jensen. "It contains no electronic components or anything that can interfere with the treatment, and we receive information about both dose rates and integrated dose".

The project is being implemented in collaboration with University Hospital Malmö, Oklahoma State University as well as the US dosimetry company Landauer. If the equipment is put into production, the result will be a treatment which is more targeted with fewer side-effects and less trouble for cancer patients; it will also save hospital time.

## DEVELOPMENT LINE

*In connection with the establishment of Risø National Laboratory, a department is set up in 1957 which specialises in radiation research.*

*The department brings together experience with thermoluminescence and subsequently optically stimulated luminescence for measuring radiation.*

*The technology is used, among things, for the dating of geological and archeological finds.*



## EFFECT



Read more about the Radiation Research Department at [www.risoe.dk/nuk/](http://www.risoe.dk/nuk/)

The American project partner is an expert in the production of dosimeters – read more at [www.landauerinc.com](http://www.landauerinc.com). At [www.risoe.dk/rispubl/NUK/nuklear.htm](http://www.risoe.dk/rispubl/NUK/nuklear.htm) it is possible to download publications about dosimeters and optical luminescence.

Equipment is developed for dating based on optically stimulated luminescence – today this can be found in laboratories worldwide.

The development project results in transportable systems for measuring radiation doses in cancer treatment.

Future perspective: The system is now in widespread use in all Danish hospitals, minimising instances of incorrect dosage and causing patients to experience less inconvenience for an enhanced quality of life.

# Focus on management and recruitment

IN 2003, RISØ'S MANAGEMENT ACADEMY REALLY STARTED PROVING SUCCESSFUL. AT THE SAME TIME, STUDENT JOBS AND OTHER EDUCATIONAL ACTIVITIES PROVIDED A SATISFACTORY RECRUITMENT PLATFORM.

## *Risø – with a good image*

*From 2002 to 2003, Risø took a big leap up more than 20 places in the leading Danish engineering magazine Ingeniøren's image survey.*



*"We go to a lot of effort to be a good employer in the local community," concludes Ulla Rasmussen, Personnel Manager.*

The Management Academy was established in 2002 and runs in 2003/2004 as a two-year pilot project. All senior managers as well as programme and task managers participate in the academy, the aim of which is to improve management skills and competences.

In 2003, a management evaluation was carried out involving each manager's superior, colleagues and employees in the assessment. The results were presented in collaboration with a psychologist, and individuals were able to draw up personal action plans.

"Furthermore, a network of interdisciplinary groups was established," says Ulla Rasmussen, Personnel Manager. "Participants have benefited enormously as they were given a platform from where to discuss relevant problems".

### **Recruitment, diversity and openness**

In 2003, Risø has been fortunate to attract many students – including more than 50 summer students. Through participating at job fairs and being more visible in the educational area, we have been able to welcome many talented people.

Through supporting and participating in educational activities, Risø gains a better recruitment platform, while society benefits from high-quality training programmes.

Risø has also looked favourably at employees wanting flexi jobs, and who come from a different ethnic background. The Personnel Manager emphasises that openness and diversity play an important role. "We go to a lot of effort to be a good employer in the local community," concludes Ulla Rasmussen.



## Environment and safety



*"We are now separated from the nuclear plants, and decommissioning the plants is not an area that involves us," says Hanne Troen, Safety Manager.*

A GOOD WORKING ENVIRONMENT IS IMPORTANT FOR EMPLOYEES, AND NEIGHBOURS IN THE LOCAL COMMUNITY MUST FEEL SAFE WITH RISØ. RESPONSIBLE CONDUCT AND SAFETY MANAGEMENT SUPPORT OUR OBJECTIVES IN THESE AREAS.

Safety, the environment and well-being are extremely important for Risø, and improvements within these fields are an integrated part of the company. Risø's safety policy was revised in 2002. The aim is to meet the requirements for certification in the safety area.

"In 2003, we were separated from the nuclear plants, and decommissioning the plants is therefore an area that no longer involves us," explains Hanne Troen from the Safety Secretariat. "However, as our research is largely experimental, we still focus on machine safety, chemicals and radiation protection. In 2003 this applied to CE marking of machines and chemical APV".

### **Keeping a watchful eye on the environment**

Improvements within the energy area have meant that consumption is unchanged despite increases in the level of activity. A pilot project was initiated in 2003 which will establish targets for the consumption of electricity, water and heating and the recycling of paper.

Risø also invests resources in introducing all new employees to safety. With first aid and fire safety courses etc., the objective is for everyone to be up to date and competent in this area.

In other words, a lot is being done in different areas, and this means that employees and the local community can feel safe with Risø as a workplace and neighbour.

Risø's green accounts can be seen at [www.risoe.dk/risoedk/Sikkerhed/sikkerhed.htm](http://www.risoe.dk/risoedk/Sikkerhed/sikkerhed.htm)

# A good experience at Risø

DENMARK'S EARNINGS AND WELFARE MUST INCREASINGLY BE BASED ON KNOWLEDGE AND DANES MUST UNDERSTAND HOW RESEARCH CONTRIBUTES TO EMPLOYMENT AND WELFARE. FOR THIS REASON RISØ IS OPENING ITS DOORS TO THE EDUCATIONAL SECTOR, COMPANIES AND ASSOCIATIONS.



In 2003, about 3,000 people – divided between 100 groups – visited Risø's Visitor Centre. These included pupils from primary and lower and upper secondary schools, associations and companies; they were given a presentation of Risø as well as of selected fields through a mix of talks and experiments.

"What we offer is tailored to our guests," says the centre's manager Eva Max Andersen. "Young schoolchildren must primarily have a good time, whereas we promote ourselves a bit more with older pupils, aiming to make them consider studying science".

## Worthwhile visit

Risø is presented to visitors through a mix of tours, talks and experiments. In 2003, focus has been on energy, bioproduction and materials. Several themes are being developed, and a special programme for upper secondary schoolchildren is expected to be ready in 2004, including an interactive exhibition.

The five guides working at the Visitor Centre provide visitors with a theoretical background as well as conducting practical experiments to help explain topics. Guided tours of the entire site give an impression of the size of the laboratory, its various fields of activity and Risø's overall significance for Danish society.

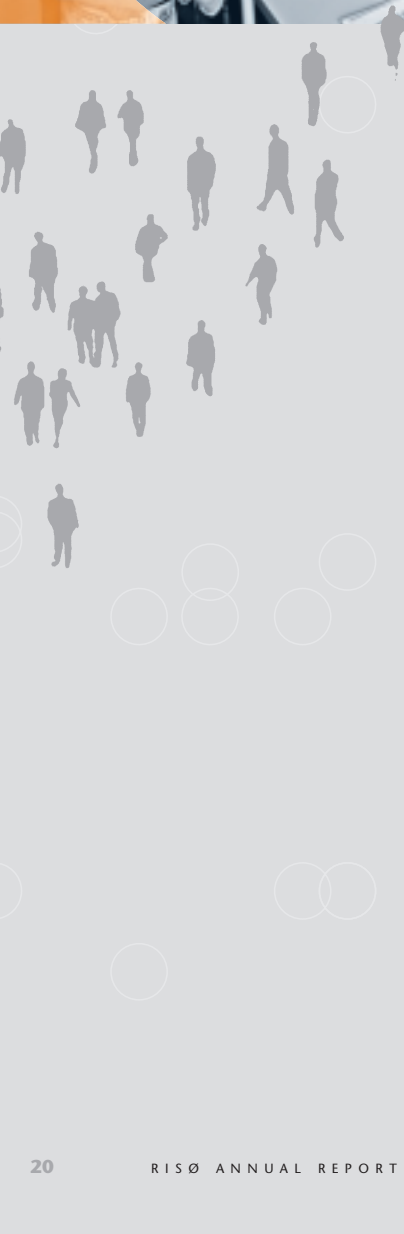
## Mutual learning through dialogue

These activities are very important to Risø, and not just from a PR point of view. It is important to invite schoolchildren and other interested parties to Risø for a direct dialogue. And also the visits provide good training in communicating knowledge in an interesting and easy-to-understand way.

Externally, the Visitor Centre's activities will make Risø more widely known, while the general public will gain a deeper understanding of the role that research can play in the development of society.



*"We want to find people who will be good ambassadors for research and technology in relation to the outside world," says the centre's daily manager, Eva Max Andersen.*



# Management and organisation

## BOARD OF GOVERNORS

Risø is managed by a ten-strong Board of Governors. The chairman and the other board members are appointed by the Minister for Science, Technology and Innovation. From this group, two members are elected by and from among the staff at Risø.

Jørgen Mads Clausen,  
President and CEO Danfoss  
A/S, Chairman of the Board

Annette Toft, Vice Director  
Danish Agricultural Council,  
Vice Chairman  
(From 1 December 2003)

Birthe Skands, Director  
Bimoco A/S, Vice-chairman  
(Until 30 November 2003)

Mette Kirstine Agger, CEO  
7TM Pharma  
(From 1 March 2004)

Per Buch Andreassen,  
Consultant doctor, Copenhagen  
University Hospital, Gentofte  
(Until 31 August 2003)

Knut Conradsen,  
Vice-Rector, Professor, Technical  
University of Denmark  
(Until 31 August 2003)

Jørgen Elikofer,  
Head of Secretariat, Dansk Metal  
(Until 31 August 2003)

Anders Flodström, President  
KTH Royal Institute of  
Technology, Stockholm  
(From 1 December 2003)

John Agertoft Hansen, Buyer  
Risø National Laboratory  
Elected by Risø staff  
(Until 1 February 2003)

Peter Høstgaard-Jensen,  
CEO and Group President  
Elsam A/S  
(From 1 December 2003)

Torben Mikkelsen,  
Senior Scientist  
Risø National Laboratory  
Elected by Risø staff

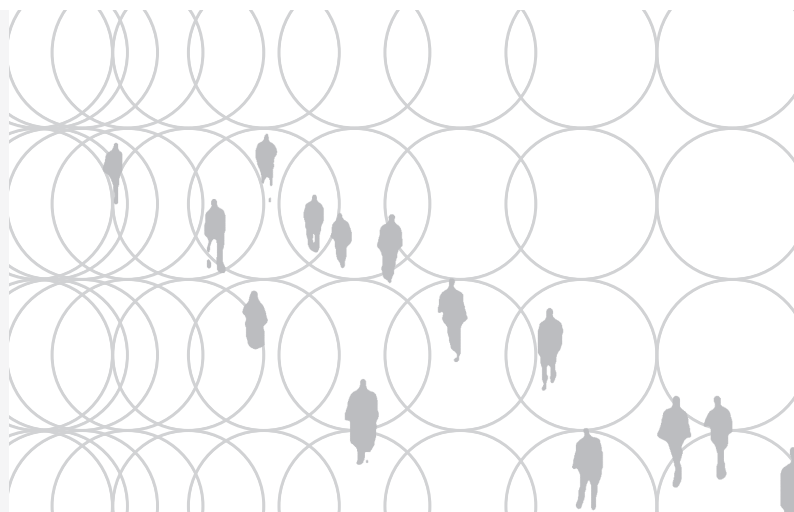
Karl Gustav Nielsen, Director  
Vestas Wind Technology  
(From 1 March 2003)

Ulla Röttger, Director  
Amagerforbrænding

Birgitte Sloth, Professor  
University of Southern Denmark  
(From 1 December 2003)

Janne Thygesen,  
Senior Assistant  
Risø National Laboratory  
Elected by Risø staff  
(From 1 February 2003)

Lisbeth Grønberg,  
Head of Management Secretariat  
Risø National Laboratory  
Secretary to the Board of  
Directors



## MANAGEMENT

Jørgen Kjems,  
Managing Director

Jon Wulff Petersen,  
Deputy Director

## HEADS OF DEPARTMENTS

Wind Energy  
Erik Lundtang Petersen

Jens Kossmann  
(Until 30 June 2004)

Materials Research  
Robert Feidenhans'l

Building & Construction Service  
Freddy Mortensen

Optics and Plasma Research  
Jens-Peter Lynov

Information Service  
Birgit Pedersen,  
Head of Department  
Leif Sønderberg Petersen,  
Public Relations Officer

Radiation Research  
Benny Majborn

Systems Analysis  
Hans Larsen

IT Service  
Erik Kristensen

Polymers  
Kristoffer Almdal  
(From 1 October 2003)  
Klaus Bechgaard (Appointed  
from 30 September 2003)

Administration  
Lisbeth Grønberg, Head of  
Management Secretariat  
Minna Nielsen, Office Manager  
Ulla Rasmussen, Personnel  
Manager  
Hanne Troen, Safety Manager

Plant Research  
Kim Pilegaard  
(Appointed from 1 July 2004)

# Effect-oriented strategy

RISØ TAKES RESPONSIBILITY FOR THE EFFECTS OF ITS RESEARCH IN SOCIETY AT LARGE. THIS HAPPENS THROUGH FORMULATING A STRATEGY WHERE THE UNDERLYING IDEA IS TO ACHIEVE MAXIMUM EFFECT FROM OUR ACTIVITIES. AND IT HAPPENS THROUGH THE EXPEDIENT INTERNAL ORGANISATION OF ACTIVITIES, WHICH ENSURES THAT BOTH RISØ AND ITS INDIVIDUAL EMPLOYEES ARE ABLE TO ACT RESPONSIBLY AND EFFICIENTLY.

As mentioned previously, the effect of Risø's research is a decisive element in the laboratory's *raison d'être*. It is at the heart of Risø's activities that the work has a perceptible effect within areas such as sustainable energy, employment, competence building, a clean environment and health.

The vision is to continue our contribution to sustainable technological development by combining research, education and innovation. If we look at Risø's competences and compare them with this vision, we are then able to visualise the paths to maximum effect (see figure).

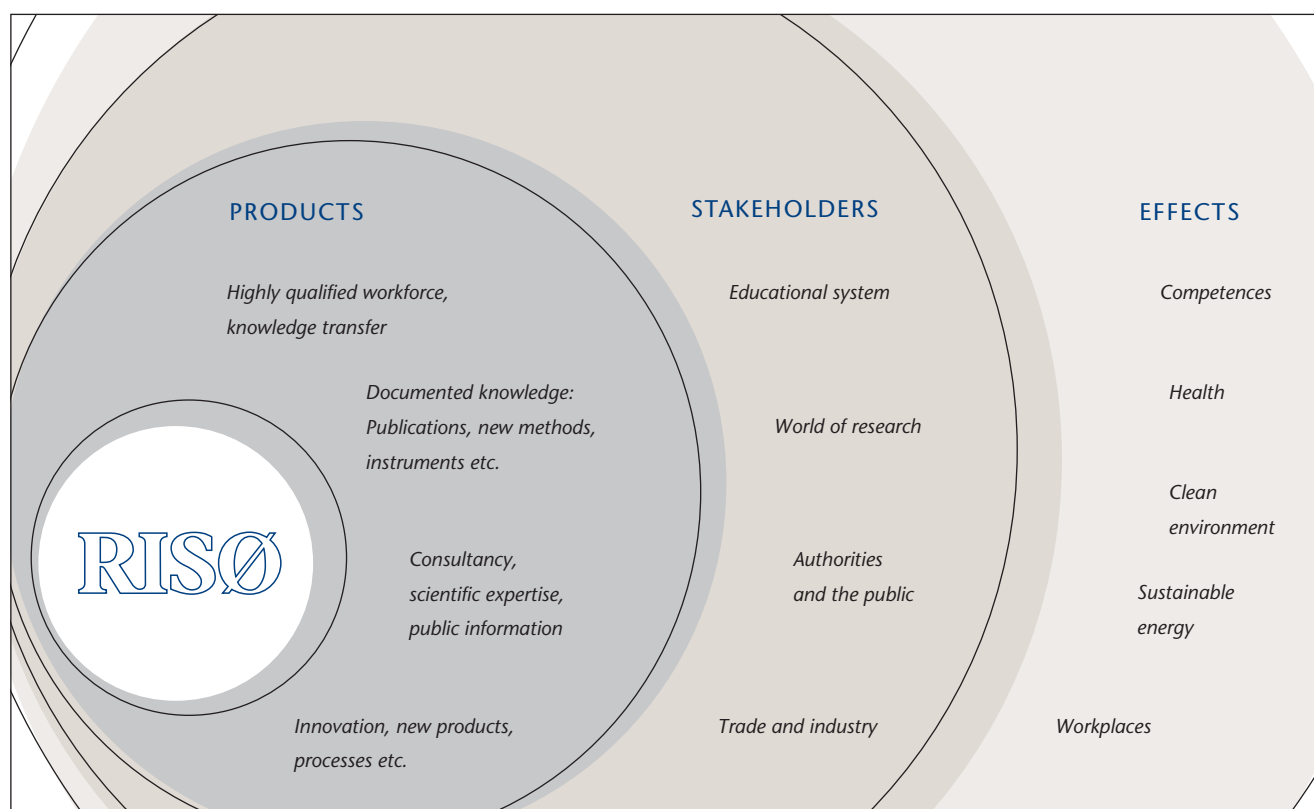
## What happens in practice?

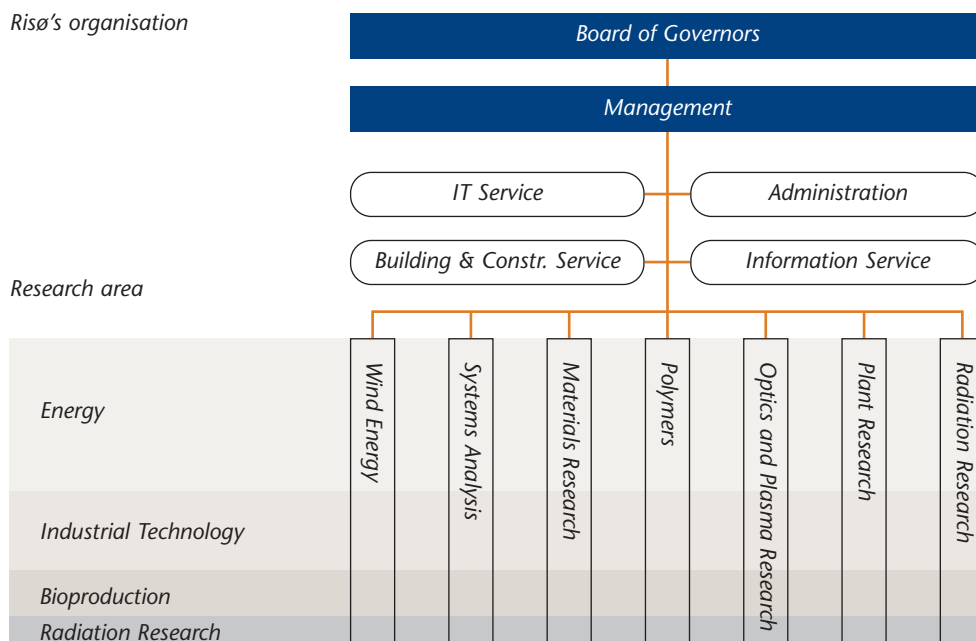
A strategy process has been launched which involves Risø's management and employees. This is an important element in the dynamic development of Risø's activities and will, by the end of 2004, result in a newly formulated strategy. Part of this process is an assessment of how to measure the effect of research.

Risø does not produce goods which can be measured and weighed. There is no sales chart to refer to. Which is why it is important to discuss how the effect of Risø's activities can be assessed, thereby ensuring that what we are doing is on the right track at all times.

An important point here is that there are different driving forces behind Risø's work. Some research areas are being propelled by political powers, while others are being carried forwards by market forces. An important contribution to a sustainable knowledge economy is bridge-building and creating similar interests.

## PATH TO EFFECT





### Wind Energy

Research into wind energy as part of the sustainable energy system of the future. Risø participates, for example, in the Danish Research Consortium for Wind Energy. This has an effect on growth, welfare, reliability of supply and compliance with the Kyoto protocol.

### Systems Analysis

Research into analysis methods and choice of new energy technologies. Research into safety and reliability in industrial production as well as the basis for new technological investments. Societal effect is e.g.: Sustainable energy sector as well as the choice of new technology and industrial production.

### Materials Research

Research into new materials and components for future energy systems. Way in to international research facilities within the fields of synchrotron radiation and neutrons as well as electron microscopy. Effect with regard to new materials and techniques as well as transferring knowledge and technology to industry.

### Polymers

Research, education and development within the field of polymers and molecular materials. Part of the Danish Polymer Centre through a cooperation agreement with DTU. Effect: new polymer-based materials which can promote the development of a high-tech society.

### Optics and Plasma Research

Research into optics, plasma physics and fluid dynamics as well as the interaction between light and matter. Also contributes to the development of fusion energy. Effect: new innovative products, reducing environmental impacts from energy production as well as optical techniques for medicine and plant biology.

### Plant Research

Research into plants' genetic products with a view to producing tailor-made raw materials within the field of foodstuffs, feeds, medicine and energy. The effect is the development of sustainable agriculture for both industrialised countries and developing countries as well as the CO<sub>2</sub>-neutral production of high-quality products.

### Radiation Research

Research into radiation protection, nuclear safety, radioactivity in the environment and the industrial application of nuclear methods. Effect: a knowledge centre for nuclear safety, radiation protection and radioecology. New Hevesey Laboratory boosts efforts within the medical field.

### Target groups

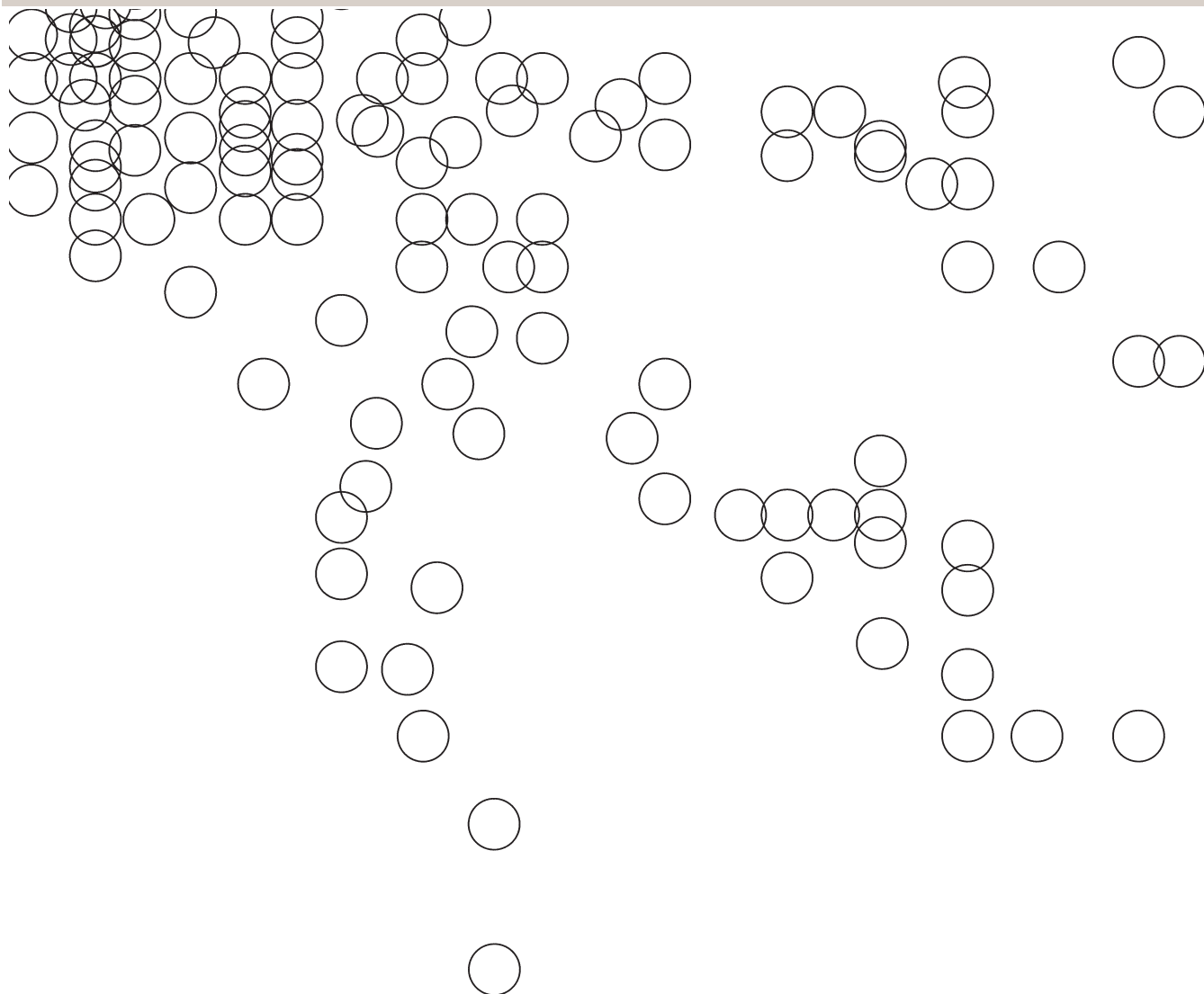
Risø is in dialogue with industry within the following areas: the wind turbine industry, energy companies, plant growers, the food industry, high-tech companies etc. Furthermore, Risø collaborates with public authorities, organisations, institutes, universities as well as other scientists and educational institutions.

*Risø Decommissioning, a financially independent department, on 15 September 2003 became an independent state institution, Danish Decommissioning (DD). DD is responsible for decommissioning Risø's nuclear facilities, the aim being for the areas and useable buildings to be used without any safety limitations.*

# Income statement

Risø National Laboratory	2001	2002	2003	2004
(All figures in DKK million)	Accounts	Accounts	Accounts	Budget
<b>Revenue</b>	<b>526,0</b>	<b>529.8</b>	<b>537.0</b>	<b>553.8</b>
Government appropriations				
Funding under the Danish Appropriations Act	243.2	242.5	239.7	237.0
Additional grant/disp. limitation	18.6	1.3	0.0	0.0
Other contracts	167.4	166.7	154.5	187.6
Market-controlled activities	96.8	108.3	129.9	121.2
Services Risø/RD	0.0	11.0	13.0	8.0
<b>Current expenditure</b>	<b>453.8</b>	<b>458.4</b>	<b>471.3</b>	<b>497.2</b>
Wages and salaries, Risø	275.6	280.0	297.3	314.0
Operation, Risø	178.2	178.4	174.0	183.2
<b>Operating profit</b>	<b>72.1</b>	<b>71.4</b>	<b>65.7</b>	<b>56.6</b>
<b>Investments and adjustments</b>	<b>53.7</b>	<b>75.5</b>	<b>43.6</b>	<b>73.2</b>
Investment pool	12.8	17.6	17.0	45.2
Wind Energy Centre and Høvsøre	22.5	39.5	4.2	0.0
Adjustment pool	0.0	0.0	0.0	10.0
Departmental investments	18.4	18.4	22.4	18.0
<b>Net profit</b>	<b>18.4</b>	<b>-4.0</b>	<b>22.2</b>	<b>-16.6</b>

# << *PhD degrees, prizes, appointments and awards in 2003*



More detailed accounts are available in Risø's Annual report 2003. Follow-up on the plans for 2003, edited by Lis Rosendahl, Ernst Aabling-Thomsen and Jørgen Kjems, Risø-R-1439(DA) in Danish. The report is available at [www.risoe.dk](http://www.risoe.dk)



# *PhD degrees awarded in 2003*

## **Wind Energy Department**

Ebba Dellwik, Technical University of Denmark

Pedro Rosas, Technical University of Denmark

## **Systems Analysis Department**

Hanne Albrechtsen, Aalborg University

Jon Olav Pedersen, Copenhagen Business School

## **Materials Research Department**

Asger Abrahamsen, Technical University of Denmark

Jesper Christiansen, Technical University of Denmark

Anders Reves Dinesen, Technical University of Denmark

Christian Højerslev, Technical University of Denmark

Lars Mikkelsen, University of Southern Denmark

Trine Bjerre Pedersen, Technical University of Denmark

## **Polymers Department**

Anders Bach, Technical University of Denmark

Rita Carrotta, The Royal Veterinary and Agricultural University

Chengzhi Chuai, Technical University of Denmark

Ruya Eskimerger, Technical University of Denmark

Holger Spanggaard, Technical University of Denmark

## **Optics and Plasma Research Department**

René Lynge Eriksen, Technical University of Denmark

Peter Snoer Jensen, Lund University

Kim G. Jespersen, Technical University of Denmark

Steven Kitchen, industrial PhD, Kamstrup A/S and Technical University of Denmark

## **Plant Research Department**

Kim Burhenne, The Royal Veterinary and Agricultural University

Kristoffer Jonasson, Roskilde University

Klaus Petersen, University of Copenhagen

## **Radiation Research Department**

Kristina J. Thomsen, Technical University of Denmark

# *Prizes, appointments and awards in 2003*

## **Wind Energy Department**

Jakob Mann has been appointed research professor at Risø.

## **Materials Research Department**

Per-Anker Lindgård has been appointed adjunct professor at the Technical University of Denmark.

## **Materials Research Department**

Desmond F. McMorow has been awarded the Allan Mackintosh Award.

## **Materials Research Department**

Mogens Mogensen has been appointed research professor at Risø.

## **Materials Research Department**

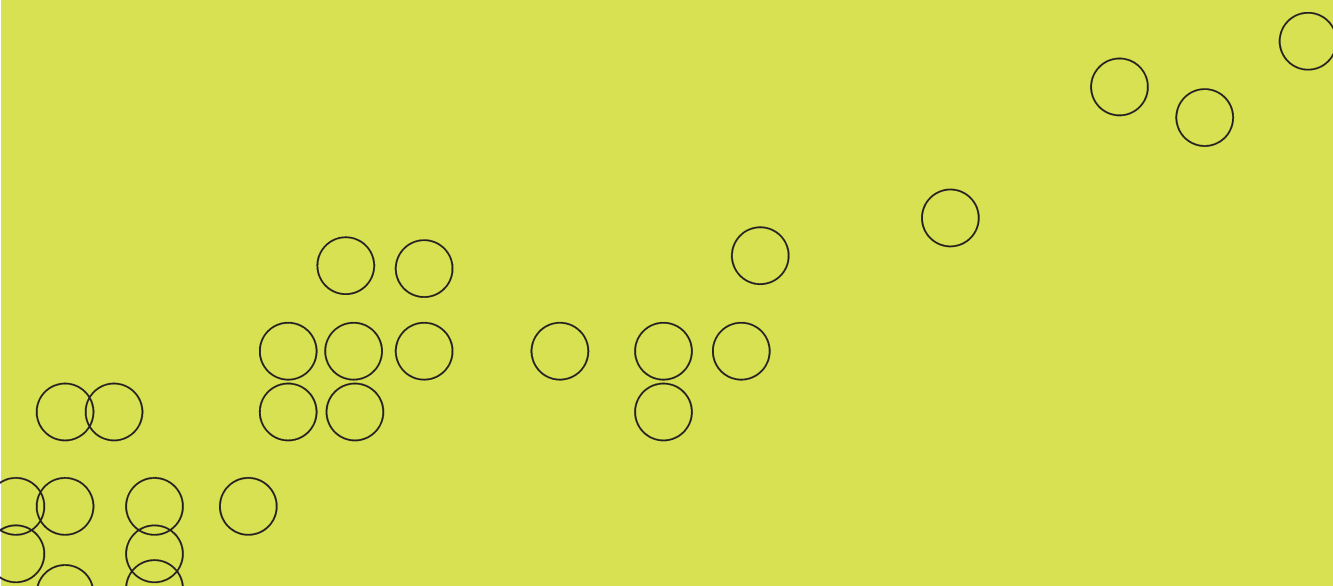
Martin Søgaard has been awarded the Elektrofondets Kandidatpris award from The Society of Danish Engineers.

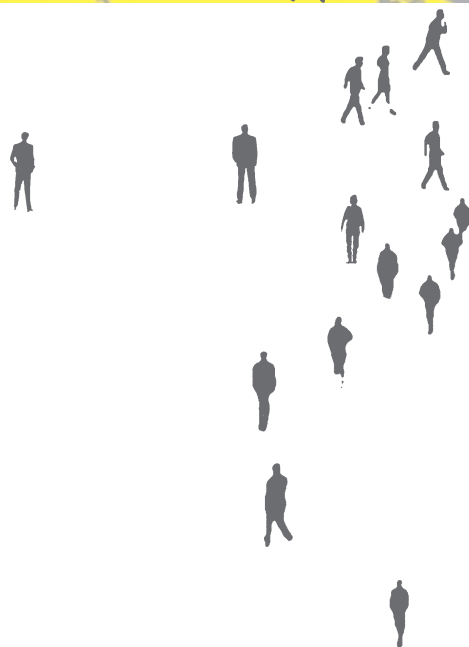
## **Polymers Department**

Niels B. Larsen has been appointed research professor at the University of Southern Denmark and Risø.

## **Plant Research Department**

Erik Steen Jensen has been awarded the Bertebos Prize 2003. The prize is awarded by the Royal Swedish Academy of Agriculture and Forestry for ground-breaking development methods within food, agriculture, animal welfare or ecology.





RISØ

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